

WHAT IS CLAIMED IS:

1           1.       A magnetic tunnel junction device, comprising:  
2           a first magnetic layer and a second magnetic layer, at least one of the first and the  
3       second magnetic layers configured to include diffusion components selected to adjust one  
4       or more properties of the tunnel junction device; and  
5           a barrier layer disposed between the first and the second magnetic layers and  
6       incorporating diffusion components migrated from the at least one magnetic layer,  
7       wherein the migrated diffusion components adjust the one or more properties of the  
8       tunnel junction device.

1           2.       The device of claim 1, wherein the diffusion components are selected to  
2       reduce a series resistance of the barrier layer.

1           3.       The device of claim 1, wherein the diffusion components are selected to  
2       decrease a bandgap of the barrier layer.

1           4.       The device of claim 1, wherein the diffusion components are selected to  
2       passivate an interface of the barrier layer.

1           5.       The device of claim 1, wherein:  
2           the first magnetic layer is a pinned magnetic layer; and  
3           the second magnetic layer is a free magnetic layer.

- 1           6.     The device of claim 1, wherein at least one of the first and the second  
2     magnetic layers is a multi-layer structure.
- 1           7.     The device of claim 1, wherein the at least one layer comprises an alloy of  
2     CoFe.
- 1           8.     The device of claim 7, wherein the alloy of CoFe comprises CoFeHf.
- 1           9.     The device of claim 8, wherein the CoFeHf comprises about 5 to about 10  
2     atomic percent Hf.
- 1           10.    The device of claim 7, wherein the alloy including CoFe comprises  
2     CoFeZr.
- 1           11.    The device of claim 10, wherein the CoFeZr comprises about 5 to about  
2     10 atomic percent Zr.
- 1           12.    The device of claim 1, wherein the diffusion components comprise Hf.
- 1           13.    The device of claim 1, wherein the diffusion components comprise Zr.
- 1           14.    The device of claim 1, wherein the barrier layer has a thickness of about 3  
2     to about 6  $\Delta$ .

1           15.     The device of claim 1, wherein the barrier layer including the migrated  
2 diffusion components comprises  $\text{AlHfO}_x$ .

1           16.     The device of claim 1, wherein the barrier layer including the migrated  
2 diffusion components comprises  $\text{AlZrO}_x$ .

1           17.     A magnetic tunnel junction sensor, comprising:  
2 a magnetic tunnel junction device comprising:  
3                 a first magnetic layer and a second magnetic layer, at least one of the first  
4 and the second magnetic layers configured to include diffusion components  
5 selected to adjust one or more properties of the tunnel junction device; and  
6                 a barrier layer between the first and the second magnetic layers, the barrier  
7 layer comprising migrated diffusion components from the at least one magnetic  
8 layer, wherein the migrated diffusion components adjust the one or more  
9 properties;  
10                a current source coupled to the first magnetic layer and the second magnetic layer;  
11 and  
12                a magnetoresistance detector, coupled to the first and the second magnetic layers,  
13 for detecting an electrical resistance through the magnetic tunnel junction device based  
14 on magnetic orientations of the first and the second magnetic layers.

1           18.     The device of claim 17, wherein the diffusion components are selected to  
2 reduce a series resistance of the barrier layer.

1           19.    The device of claim 17, wherein the diffusion components are selected to  
2   decrease a bandgap of the barrier layer.

1           20.    The device of claim 17, wherein the second magnetic layer is a free  
2   magnetic layer.

1           21.    The device of claim 17, wherein the first magnetic layer is a pinned multi-  
2   layer magnetic structure.

1           22.    The device of claim 17, wherein the first magnetic layer comprises an  
2   alloy of CoFe.

1           23.    The device of claim 17, wherein the alloy of CoFe comprises CoFeHf.

1           24.    The device of claim 17, wherein the alloy of CoFe comprises CoFeZr.

1           25.    The device of claim 17, wherein the diffusion components comprise Hf.

1           26.    The device of claim 17, wherein the diffusion components comprise Zr.

1           27.    The device of claim 17, wherein the barrier layer has a thickness of about  
2   3 to about 6 Å.

1           28.    The device of claim 17, wherein the barrier layer including the migrated  
2   diffusion components comprises AlHfO<sub>x</sub>.

1           29.     The device of claim 17, wherein the barrier layer including the migrated  
2 diffusion components comprises  $\text{AlZrO}_x$ .

1           30.     A magnetic storage system, comprising:  
2           a movable magnetic recording medium;  
3           a magnetic tunnel junction sensor for detecting magnetic signals on the moveable  
4 recording medium, comprising:  
5                 a first magnetic layer and a second magnetic layer, at least one of the first  
6                 and the second magnetic layers configured to include diffusion components  
7                 selected to adjust one or more properties of the tunnel junction sensor;  
8                 a barrier layer between the first and the second magnetic layers, the barrier  
9                 layer including migrated diffusion components from the at least one magnetic  
10                layer, wherein the migrated diffusion components adjust the one or more  
11                properties; and  
12                a magnetoresistance detector, coupled to the first and the second magnetic  
13                layers, for detecting an electrical resistance through the magnetic tunnel junction  
14                sensor based on magnetic orientations of the first and the second magnetic layers;  
15           and  
16           an actuator, coupled to the magnetic tunnel junction sensor, for moving the sensor  
17 relative to the medium.

1           31.     The device of claim 30, wherein the at least one of the first and the second  
2 magnetic layers comprises an alloy of CoFe.

- 1           32.    The device of claim 31, wherein the alloy of CoFe comprises CoFeHf.
- 1           33.    The device of claim 31, wherein the alloy of CoFe comprises CoFeZr.
- 1           34.    The device of claim 30, wherein the diffusion components comprise Hf.
- 1           35.    The device of claim 30, wherein the diffusion components comprise Zr.
- 1           36.    The device of claim 30, wherein the barrier layer including the migrated  
2 diffusion components comprises AlHfO<sub>x</sub>.
- 1           37.    The device of claim 30, wherein the barrier layer including the migrated  
2 diffusion components comprises AlZrO<sub>x</sub>.
- 1           38.    A memory device, comprising:  
2            an array of memory elements configured to store information for later access,  
3            each memory element comprising:  
4                a first magnetic layer and a second magnetic layer, at least one of the first  
5                and the second magnetic layers configured to include diffusion components  
6                selected to adjust one or more properties of the memory element; and  
7                a barrier layer between the first and the second magnetic layers, the barrier layer  
8                comprising migrated diffusion components from the at least one magnetic layer, wherein  
9                the migrated diffusion components adjust the one or more properties.

1           39.    A tunnel junction device, comprising:  
2                   means for providing a first magnetic layer incorporating diffusion  
3 components selected to adjust one or more properties of the tunnel junction device;  
4                   means for providing a second magnetic layer;  
5                   means for providing a tunnel barrier layer between the first and the second  
6 magnetic layers, the tunnel barrier layer including migrated diffusion components from  
7 the first magnetic layer, wherein the migrated diffusion components adjust the one or  
8 more properties of the tunnel junction device.

1           40.    A magnetic tunnel junction sensor, comprising:  
2                   means for providing a first magnetic layer configured to include diffusion  
3 components selected to adjust one or more properties of the tunnel junction  
4 sensor; and  
5                   means for providing a second magnetic layer;  
6                   means for providing a barrier layer between the first and the second  
7 magnetic layers, the barrier layer comprising migrated diffusion components from  
8 the first magnetic layer, wherein the migrated diffusion components alter the one  
9 or more properties; and  
10                  means for measuring an electrical resistance through the first and the second  
11 magnetic layers and the barrier layer based on magnetic orientations of the first and the  
12 second magnetic layers.

1           41.    A magnetic storage system, comprising:  
2           means for storing magnetic data;  
3           means for sensing the magnetically stored data, comprising:  
4                 means for providing a first magnetic layer configured to include diffusion  
5           components selected to alter one or more properties of the sensing means;  
6                 means for providing a second magnetic layer; and  
7                 means for providing a barrier layer between the first and the second  
8           magnetic layers, the barrier layer including diffusion components migrated from  
9           the first magnetic layer and altering the one or more properties; and  
10                means for detecting an electrical resistance through the means for sensing  
11           based on magnetic orientations of the first and the second magnetic layers; and  
12           means for moving the means for sensing relative to the means for magnetic data  
13   storage.